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ABSTRACT

Researchers of gender differences in computer-related behaviors have reported a confusing picture. When asked which sex is more positive toward computers, more apt at using computers, and more likely to use a computer, one would be best advised to answer "it depends." It depends on what attitudes you are measuring, what skills you are assessing, what the computer is being used for, and what age group you are sampling. This review offers two suggestions to reduce this confusion. The first is to clean up the data so that we can be sure that the results reported are "real" differences. The second is to switch from a more traditional quantitative, construct-based approach to a qualitative, dynamic approach that looks at processes of human-computer interaction. Several examples of the kind of useful theoretical and practical information that can be gleaned from a more process-oriented style are offered. By addressing process, researchers can address and alter the inequities that exist regarding the use of computers. (79 references) (Author)

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An Examination of Gender Differences in Computer Attitudes, Aptitude, and Use

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Abstract

Researchers of gender differences in computer-related behaviours have reported a confusing picture. When asked which sex is more positive toward computers, more apt at using computers and more likely to use a computer, one would best be advised to answer "it depends." It depends on what attitudes you are measuring, what skills you are assessing, what the computer is being used for, and what age group you are sampling. This review offers two suggestions to reduce this confusion. The first suggestion is to clean up the data so that we can be sure that the results reported are "real" differences. The second suggestion is to switch from a more traditional quantitative, construct-based approach to a qualitative, dynamic approach that looks at processes of human-computer interaction. Several examples of the kind of useful theoretical and practical information that can be gleaned from a more process-oriented style are offered. By addressing process, researchers can address and alter the inequities that exist regarding the use of computers.

An Examination of Gender Differences in Computer Attitudes, Aptitude, and Use

In the past 5 to 7 years, research on gender differences in behaviours toward computers has increased dramatically. Many articles have been written examining differences between males and females with respect to attitudes toward computers, aptitude, and actual use. A review of this research offers a confusing and disjointed story at best.

For example, while males had more positive attitudes on 48 out of 98 instances of attitude measurement, females had more positive attitudes on 14 occasions, and males and females had similar attitudes on 36 occasions (Kay, 1992a). A similar picture is seen with respect to computer aptitude. Out of 32 occasions of aptitude measurement, males outperformed females 15 times, females outperformed males 5 times, and males and females performed equally well on 13 occasions (Kay, 1992a). Finally, males clearly used computers more the females (30 out of 38 occasions).

The situation is complicated further by the numerous definitions offered for attitudes (acceptance, affect, cognitions, comfort, confidence, courses, interest, liking, locus of control, motivation, programming, training, case scenarios, stereotypes) computer aptitude (application software, awareness, experience, terminology, the LOGO programming language, map construction, general programming, word processing, and games) and computer use (camp participation, computer course enrolment,

games, playing with graphs, ownership of computers, style, word processing, and general extra curricular activities) (Kay, 1992a).

In addition, a large range of age groups or content areas have been examined including pre-school, primary-school (K-3), middle-school (grades 4-8), high school (grade 9-12), university, teachers, adults at work, and media advertisements. In a number of cases the differential effects of group membership are ignored (Kay, 1992a).

Identifying consistent patterns and explanations in this quagmire of constructs and age groups are enormously difficult tasks. Part of the difficulty lies in empirical techniques used to investigate human-computer interaction. A detailed and comprehensive review of methods used to examine gender differences in attitudes, aptitude and reveals that a number of procedural flaws significantly limits the consistency, validity and impact of many studies. One strategy for addressing the confusing results that have been reported is to "clean up" the data. In most cases, easy remedies are available.

A second difficulty with current gender-computer research lies in the style of data collection. Most researchers have chosen a survey approach. This relatively straightforward design has produced a wealth of well-organized, albeit conflicting, descriptive data. While reliable, valid, descriptive data is critical for any comprehensive research endeavour, it has yet to provide a coherent, comprehensive understanding of why males and

females differ in their behaviour toward computers. Instead of a coherent structure unfolding from these studies, one has the feeling of having to construct a jigsaw puzzle without a pattern or model from which to work. There are many pieces but very few clues about how they fit together. It will be argued that there is a need for more process-oriented research focusing on how attitudes, ability, and dispositions for using computers develop. This involves doing a more qualitative, contextual, developmental examination of specific computer-related tasks.

The following paper, then, is a critique of methods used by investigators to explore gender disparities in behaviour towards computers. First, a critical evaluation of current methods is given, with an emphasis on improving the quality of data. Four areas where common methodological and statistical mistakes are made will be discussed. Five straight-forward solutions are offered.

Second, alternate methods of data collection are explored with an emphasis on identifying promising strategies for building theory. Four competing philosophical traditions in educational research are discussed: a) quantitative vs. qualitative methods, b) construct vs. contextual theory of behaviour, c) general vs. specific analysis of aptitude, and d) static vs. developmental designs. To date, most researchers have used a quantitative, construct and somewhat static approach, focusing on general ability. This kind of research is critical to identifying the nature and complexity of gender differences. To unravel this

complexity, though, more research is needed using a qualitative, contextual and developmental design that looks at specific cognitive tasks. This kind of design will allow researchers to address "basic" assumptions and to build theory.

Cleaning Up the Data

No researcher endeavour is without fault. Investigators are forced to juggle a number of mutually exclusive constraints. Decisions have to be made about sample size, sample selection, how to define constructs such as attitude, aptitude and use, and how to analyze one's data. The near perfect study is a rare, and perhaps impossible achievement. There are ways, though, that we can address imperfection. Four areas where common mistakes are made include sample selection, scale development, statistical analysis, and presentation of results.

Problems with sample selection include lumping a large range of age groups into one group (Chambers & Clarke, 1987; Harvey & Wilson, 1985; Hattie & Fitzgerald, 1987; Kwan, Trauth, & Driehaus, 1985; Marshall & Bannon, 1986; Nelson, 1988; Wilder, 1985), failure to discuss selection procedure (Loyd & Gressard, 1986) and the impact of a disproportionate number of males and females in a particular sample (Jackson & Yamanaka, 1985; Loyd & Loyd, 1989; Vernon-Gerstenfeld, 1989), leaving out a description of the selection process altogether (Anderson, 1987; Culley, 1988; Durndell, Macleod, & Siann, 1987; Koohang, 1989; Lockheed, Nielsen, & Stone, 1985; Loyd & Gressard, 1986; Loyd & Loyd, 1989; Levin & Gordon, 1989; Richards, Johnson, & Johnson, 1986), and

selecting too small a sample (Clarke & Chambers, 1989).

Problems with scale development include a seemingly arbitrary selection of scale items (Becker & Sterling, 1987; Culley, 1988; Durndell et al., 1987; Forsyth & Lancy, 1989; Kwan et al., 1985; Lockheed et al., 1985; Loyd & Gressard, 1986; Siann, Macleod, Glissov, & Durndell, 1990; Swadener & Jarrett, 1986; Ware & Stuck, 1985), borrowing items from larger scales without stating the basis for selection (Chambers & Clarke, 1987; Swadener & Hannafin, 1987), an absence of scale statistics (Forsyth & Lancy, 1989; Harvey & Wilson, 1985; Jackson & Yamanaka, 1985; Lockheed et al., 1985; Koohang, 1989; Miura, 1987; Moore & Steele, 1985; Siann, Durndell, Macleod, & Glissov, 1988; Stasz, Shavelson, & Stasz, 1985; Wilder, 1985), low reliability coefficients (less than .70) (Chambers & Clarke, 1987; Levin & Gordon, 1989; Wu & Morgan, 1989), the use of reliability estimates from other studies (Munger & Loyd, 1989, Loyd & Loyd, 1989), an insufficient number of items in a scale (Anderson, 1987; Durndell et al., 1987; Chen, 1986; Forsyth & Lancy, 1989), and a lack of appropriate construct testing (Chambers & Clarke, 1987; Clarke & Chambers, 1989; Collis, Kass, & Kieren, 1989; DeRemer, 1989; Hattie & Fitzgerald, 1987; Kay, 1989a; Koohang, 1989; Mandinach & Corno, 1985; Miura, 1987; Loyd & Gressard, 1984; Siann, Macleod, Glissov, & Durndell, 1990; Smith, 1987; Stasz et al., 1985; Swadener & Hannafin, 1987; Wilder, 1985; Wu & Morgan, 1989).

Problems with statistical analysis include inappropriate use

of multiple t-tests, chi-square analyses, correlations, and ANOVAs in place of their multivariate counterparts (Chambers & Clarke, 1989; Clarke & Chambers, 1989; DeRemer, 1989; Fetler, 1985; Gutek & Bikson, 1985; Harvey & Wilson, 1985; Hess & Miura, 1985; Kwan et al., 1985; Marshall & Bannon, 1986; Morris, 1988-89; Lockheed et al., 1985; Mandinach & Corno, 1985; Schaeffer & Sprigle, 1988; Ware & Stuck, 1985; Webb, 1985; Wilder, 1985), inadequate attention to issues of multicollinearity, number of variables, and the predictive variance accounted for in regression analyses (Clarke & Chambers, 1989; Griswold, 1983; Morris, 1988-89; Munger & Loyd, 1989).

Finally, a noticeably relaxed presentation of results, often without means, percentages or statistical significance coefficients, made conclusions questionable (Becker, 1985; Collis, 1985a; Harvey & Wilson, 1985; Hattie & Fitzgerald, 1987; Siann, Macleod, Glissov, & Durndell, 1990; Swadener & Hannafin, 1987; Swadener & Jarret, 1986).

While I have noted many methodological difficulties in gender-computer research, several careful and meticulous researchers made extensive efforts to choose representative samples (Becker, 1985; Becker & Sterling, 1987; Collis et al., 1989; Kwan et al., 1985), to develop scales thoroughly (Collis, 1985a, 1985b; Collis & Ollila, 1986; Collis & Williams, 1987; Fetler, 1985; Mandinach & Linn, 1987; Popovich, Hyde, Zakrajsek, & Blumer, 1987; Voogt, 1987), to achieve high scale reliability (Collis et al., 1989; Chambers & Clarke, 1989; DeRemer, 1989;

Enochs, 1984; Loyd & Loyd, 1989; Morris, 1988-89; Munger & Loyd, 1989; Nelson, 1988; Popovich et al., 1987; Schaeffer & Sprigle, 1988; Swadener & Hannafin, 1987; Webb, 1985), and to apply the correct statistical analyses (Collis & Williams, 1987; Hattie & Fitzgerald, 1987; Jagacinski, LeBold, & Salvendy, 1988; Koohang, 1989; Loyd & Gressard, 1984; Loyd & Loyd, 1989). These efforts should be applauded and copied.

Most of the mistakes made by researchers can be easily remedied with the following solutions. First, use random samples, and if this is not possible provide a clear description of subjects and response rate. Second, develop scales carefully. If you wish to develop your own scale, provide a detailed discussion of the process. In many cases, it would be advisable to use another, carefully constructed scale. Third, provide a detailed description of scales including scale reliability, factor loadings, and a list of scale items. Forth, use multivariate analyses in place of multiple univariate analyses. Finally, attempt to use constructs based on theory. Decisions on construct formation should not be derived solely based on indiscriminate factor analysis.

One approach to sorting out the confusing results of gender-computer research is to "clean up" the data. By reducing errors due to inappropriate sample selection, poor scale development, incorrect statistical analysis, and scanty detail in presentation of results, we can begin to critically evaluate ***real*** differences between males and females in computer-related behaviour.

Emphasizing Process

As stated earlier, most researchers examining gender differences in computer-related behaviour have chosen to use some form of survey designed to examine three principal constructs: attitudes, aptitude, and use. More often than not, only one of these constructs is investigated in a given study. The results of survey research generally consist of tables listing statistical differences between construct means. Last, the discussion section provides a list of speculations attempting to explain the results. The research abounds with all sorts of unsupported, albeit interesting, explanations (Alvardo, 1984; Gilliland, 1984; Hawkins, 1985; Lockheed, 1985; Lockheed & Frakt, 1984; Mandinach & Linn, 1986; Sanders, 1984; Schubert & Bakke, 1984; Ward, 1985).

It is important to note that the speculations made are not deliberately misleading; prevalent research methodology has made it difficult to develop a comprehensive, coherent theory. I am unaware of any published research that has developed a theoretical model or comprehensive explanation of gender differences in computer behaviour based on survey research. Like with a jigsaw puzzle, it is very hard to tell how any one piece (or study) contributes to the puzzle, therefore any picture (or theory) usually materializes at a snail's pace.

Research on gender differences must move from simply identifying differences to understanding them. This would involve at least four new approaches to investigating human-computer interaction.

First, researchers must begin to systematically collect qualitative data. The current survey method does not bring us close enough to the process behind human-computer interaction. The principal strength of quantitative analysis is its numerical precision. The principal weakness lies in the extent to which the results represent a true state of affairs. Qualitative research, on the other hand, is often an analysis of natural or real work situations, so it is inherently representative, although precise quantification of the results remains elusive.

For the most part, researchers in the past two decades have leaned strongly toward quantitative methodology. There is a history, however, of switching between quantitative and qualitative procedures, and some researchers argue that the pendulum is starting to swing toward the qualitative pole (Fetterman, 1988). There are indications that gender-research may begin to experience a shift from quantitative to qualitative research. Some very promising qualitative data are already trickling in (Clarke, 1990; Lipinski, Nida, Shade, & Watson, 1986; Siann & Macleod, 1986; Turkle, 1984; Turkle & Papert, 1990; Vernon-Gerstenfeld, 1989).

Achieving a balance between quantitative and qualitative methods is probably ideal. Currently, the balance leans heavily toward quantification. I argue that the situation is unproductive and unsatisfactory, particularly in terms of developing theory.

Second, a more contextual, as opposed to construct philosophy, is needed to sort out conflicting results. Previous

researchers have assumed that attitudes toward computers, aptitude, and use represent distinct and identifiable constructs. This is an intuitively appealing approach, at least in terms of simplifying descriptions and explanations of behaviour. Unfortunately, it is not clear what investigators mean by attitude or aptitude, as evidenced by the multitude of definitions offered in the literature. Munger & Loyd (1989) speculated that technology inevitably influences attitudes toward computers, and that it would be a mistake to think of attitude as a static concept. Kay (1989b), in a comprehensive review of the literature, noted at least five strategies used to define the term computer literacy. He also observed that the definition of computer literacy seemed to evolve with the technology (Kay, in press). Given the variety and evolving nature of supposed computer-related constructs, it might be best to look to a contextual framework when conceptualizing human-computer interaction. With the contextual model, researchers observe and describe behaviour in terms of a number of variables interacting in a particular environment. This kind of data takes more effort to collect, describe, and comprehend, but it does not obscure the intricacies and complexities known to exist in everyday behaviour.

It is suggested that a contextual or situational approach to research can provide a) a preliminary understanding of how children's attitudes toward computers develop, b) certain prototypical patterns of how various factors such as gender,

family background and skill interact with computer attitudes, and c) a rich source of information for developing instructional strategies to teach computer related tasks.

Third, factors that are more fundamental than attitude, aptitude and use constructs need to be examined. The use of these constructs tends to promote an emphasis on general tendencies at the expense of individual differences. But Keating (1989) notes :

> Evidence of cognitive diversity is pervasive; understanding its sources and trajectories ... is fundamental to understanding cognition (p.5).

A general learning approach obscures the details of specific learning environments. By assuming that all knowledge is acquired in a similar fashion, researchers ignore potentially important differences that are illuminated by investigating specific cognitive tasks such as programming, word processing, spreadsheet software, or computer terminology. With respect to gender differences, it may be necessary to focus on specific behaviours to get a clearer, more complete understanding of the "trajectories" of acquiring computer-related behaviours.

Finally, a developmental approach is required to acquire a more precise understanding of how behaviours associated with attitude, aptitude and use emerge. Researchers have examined a broad age range of subjects from preschoolers to adults. Unfortunately the diversity of age groups has given us little insight into the development of computer attitudes, aptitude and use. Researchers have either focused on a single age group or

failed to dissect large composites (Chambers & Clarke, 1987; Harvey & Wilson, 1985; Hattie, & Fitzgerald, 1987; Kwan et al., 1985; Marshall & Bannon, 1986; Nelson, 1988; Wilder, 1985). Only DeRemer (1989) addressed the issues of attitude development.

A longitudinal and developmental focus is informative for two reasons. First, an understanding of the interaction between basic cognitive tasks and attitudes might be revealed if we observe factors such as mental states (Olson & Astington, 1987) and the nature of belief (Olson, 1988) in young children over a relatively long period.

Second, computers have only been part of everyday life for the past 10 years. Their infiltration into society is becoming ever more noticeable. The impact of computers on today's primary school students is much different from the impact of computers on primary school students of 10 or 15 years ago. It is almost impossible to realistically compare cross-sections of a population by age and even more meaningless to group them together. Longitudinal data--short term and long term--are necessary if we are to investigate the development of behaviours toward computers.

One clear benefit in this approach would be to gather information on the development of sex-typed attitudes and cognitive skills in individuals before and after they begin using computers. Research presented by DeRemer (1989) as well as Tracy (1987) and Gilligan (1982) provided good examples of fruitful research in this area.

These four alternate approaches (qualitative, contextual, specific and developmental) are necessary for building a cohesive and comprehensive theory of gender differences observed in computer-related behaviour. Without a supplement to survey methodology, we will continue to report pieces of the puzzle.

Examples of Process-Oriented Research

I will provide two examples of process-oriented research that show the potential usefulness of a qualitative, contextual approach examining specific tasks.

Turkle & Papert (1990) examined anecdotes from thirty college students enroled in a first year programming course and noted at least two different styles used to program: a formal, canonical style often used by males and an *ad hoc*, concrete style, known as "bricolage", used by females. The authors suggest that these styles are different and equally valid, a claim that runs counter to the Piagetian-Stage theory. Furthermore, they maintain the current computer culture is biased toward a "formal" style and that this bias alienates females. Several case dialogues are offered as evidence: "of fifteen women, nine were concrete style programmers, of fifteen men, four" (p.33).

This kind of theory building is virtually absent in the gender-computer literature to date. Although it might be argued that Turkle & Papert are merely "story telling", as opposed to truly developing a viable theory, perhaps a more accurate analysis is that they have generated partially supported and

coordinated ideas. Whether we call it convincing story telling or theory, Turkle & Papert's research is promising in terms of providing a plausible explanation of gender differentiated behaviour with respect to programming.

A second example involves a detailed analysis of 8 subjects, at varying levels of computer experience, learning a spreadsheet software package (Kay, 1992b). Think-aloud-protocols were examined in terms of the role of previous experience, the use of metaphors, the effect of task interpretation, use of terminology and the role of emotions. The following preliminary conclusions are made: 1) there is no clear relation between previous computer-related skills and the successful completion of spreadsheet learning tasks; 2) subjects actively attempt to learn by using a variety of metaphors, 3) task interpretation effects how subjects behave and the kind of errors they make while learning, 4) terminology is related to degree of understanding of new tasks, and 5) distinct patterns of emotion and learning emerged with respect to task type, task difficulty and subject. While the sample is too small to examine gender differences, this kind of detailed analysis can be used to explore the nature and perhaps origins of gender differences in behaviours toward computers.

A Case for Cooperation

Patricia Churchland (1986) provided a metaphor for the co-evolutionary process of overtly competing forces in a scientific endeavour.

> [It is like] two rock climbers making their way up a wide chimney by bracing their feet against the wall, each braced against the back of the other. (p. 374).

Quantitative and qualitative theorists have to work together. It is difficult for teachers and researchers alike to learn from tables of numbers alone. We need to incorporate qualitative, contextual, developmental approaches that focus on specific cognitive tasks to bring these figures to life and guide us to new knowledge.

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